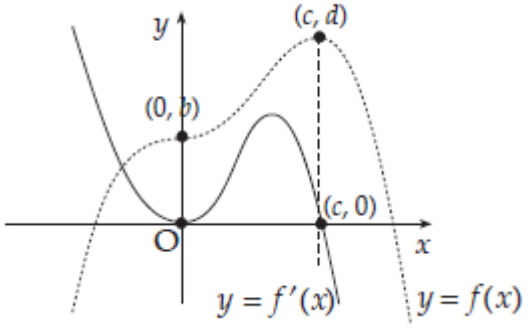
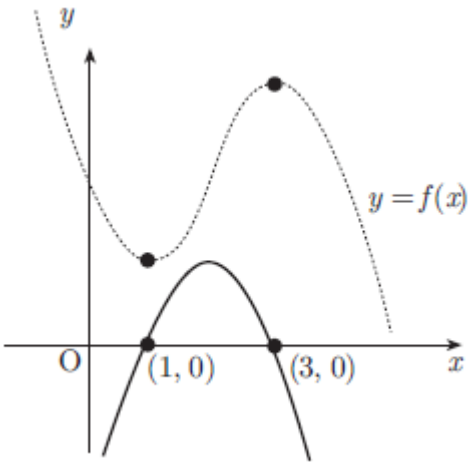
00 P1 A2	**4C, 2C, 1A** •1 $\frac{dy}{dx}$ = ... •2 $\frac{dy}{dx} = 3x^2 - 12x + 9$ •3 $3x^2 - 12x + 9 = 0$ •4 $A = (1, 4)$ $f(x)$ needs to be translated 4 units up, 2 units left •5 sketch with coord of A' $(-1, 8)$ •6 sketch with coord of B' $(1, 4)$ •7 $4 < k < 8$
01 P1 Q9	**2C** •1 st line for f' thr' $(3, 0)$, $m_{f'} > 0$ •2 st line for g' thr' $(3, 0)$, $m_{f'} > m_{g'} > 0$
01 P2 Q2	**6C** •1 $(4, -4)$ stated •2 $-16x^{-\frac{1}{2}}$ •3 $\frac{dy}{dx} = 1$ ..... •4 .....$+ 8x^{-\frac{3}{2}}$ •5 $m_{x=4} = 2$ •6 $y - (-4) = 2(x - 4)$ ans: $y = 2x - 12$
02 P1 Q4	**4C** •1 $\frac{dy}{dx} = 4x - 7$ •2 $m_{tang} = \tan 45° = 1$ •3 $4x - 7 = 1$ •4 $(2, 4)$
02 P1 Q6	**3C** •1 roots at 0 and c (accept a statement to this effect) •2 min at LH root, max between roots •3 both 'tails' correct 
6.(JAN) 02 P1	**5C**

	•1 $y = 3x^{-1}$ •2 $\frac{dy}{dx} = -3x^{-2}$ •3 $m_{x=1} = -3$ •4 $y_{x=1} = 3$ •5 $y - 3 = -3(x-1)$ **ans:** $y + 3x = 6$
03 P1 Q5	**5C** •1 $x^{\frac{1}{2}}$ •2 $2x^{-2}$ •3 $\frac{1}{2}x^{-\frac{1}{2}}$ •4 $-4x^{-3}$ •5 $\frac{3}{16}$
04 P1 Q8	**2C, 4B** •1 $(x-5)^2 \ldots$ •2 $(x-5)^2 + 2$ •3 $g'(x) =$ *STATED EXPLICITLY* •4 $x^2 - 10x + 27$ •5 $(x-5)^2 + 2$ •6 $g'(x) > 0$ for all x and so $g(x)$ increasing **OR** •3 $g'(x) =$ *STATED EXPLICITLY* •4 $x^2 - 10x + 27$ •5 $b^2 - 4ac = 100 - 108 = -8$ •6 no roots, concave up, $g'(x) > 0$ and thus $g(x)$ increasing
04 P2 Q5	**5C, 2C** •1 $\frac{dy}{dx} =$ *stated* •2 $12x - 3x^2$ •3 $12x - 3x^2 = 12$ •4 $3(x-2)^2 = 0$ •5 $x = 2$ •6 $y = 16$ •7 $y - 16 = 12(x-2)$
04 P2 Q7	**3B**

a sketch with the following details

- •1 *only two intercepts on the x - axis at 1 and 3*
- •2 *function is + ve between the roots and – ve outwith*
- •3 *a parabola (symmetrical about midpoint of x - intercepts), stated or implied by the accuracy of the diagram*



05 P2 Q6

6B

- •1 $\frac{dy}{dx} = \ldots$
- •2 $y = 24x^{-\frac{1}{2}}$
- •3 $\frac{dy}{dx} = -12x^{-\frac{3}{2}}$
- •4 $\frac{dy}{dx}_{x=4} = -\frac{3}{2}$
- •5 $y_{x=4} = 12$
- •6 $y - 12 = -\frac{3}{2}(x-4)$ $\quad 2y + 3x = 36$

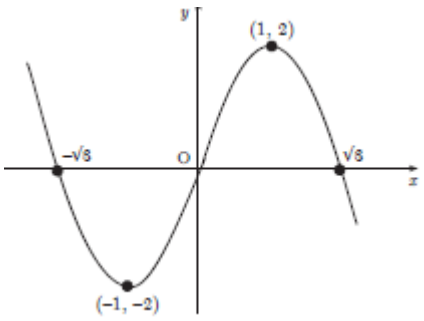
07 P1 Q9

2C/B, 7C/B, 1B

- •1 *any two of* $x = 0$, $x = \sqrt{3}$ *and* $x = -\sqrt{3}$
- •2 *remaining one*
- •3 $f'(x) =$
- •4 $3 - 3x^2$
- •5 $f'(x) = 0$

		•6	•7	
•6	x	1	-1	
•7	y	2	-2	s/i by the sketch

			•8			•9	
•8		...	-1	...	...	1	...
	f'	$-$	0	$+$	$+$	0	$-$
•9			minimum			maximum	



- •10 *sketch(see below)*

07 P2 Q5	**5C, 2B, 2B** $\bullet^1$ $\frac{dy}{dx} = \ldots$(1 term correct) $\bullet^2$ $x-8$ $\bullet^3$ $x-8=4$ $\bullet^4$ $x=12$ $\bullet^5$ $y=10$ $\bullet^6$ $m_P=-4$ $\bullet^7$ $\mathrm{P}=(4,10)$ $\bullet^8$ $x_C=8$ $\bullet^9$ $y_C=11$ *Alternative Method for (c)* Solving the normals i.e. $y-10=-\frac{1}{4}(x-12)$ $y-10=\frac{1}{4}(x-4)$ may be used. Marks are awarded as normal: $x=8$ ($\bullet^8$) and $y=11$ ($\bullet^9$)
08 P1 Q22	**5C, 2C** $\bullet^1$ $\frac{dy}{dx} = ..$(1 *term correct*) *s / i by* $\bullet^2$ $\bullet^2$ $3x^2-12x+8$ *s / i by* $\bullet^3$ $\bullet^3$ $3x^2-12x+8=-1$ $\bullet^4$ x: 1, 3 $\bullet^5$ y: 3, -3 $\bullet^6$ $y=4-x$ has gradient $=-1$ $\bullet^7$ *check* $(3,-3)$ and reject *check* $(1,3)$ and accept **Alternative for $\bullet^6$ and $\bullet^7$** $\bullet^6$ $x^3-6x^2+8x=4-x$ $x^3-6x^2+9x-4=0$ $(x-1)(x^2-5x+4)$ $(x-4)(x-1)$ $\bullet^7$ repeated root implies tangent at $(1,3)$.
09 P2 Q1	**8C**

$\bullet^1$ $\frac{dy}{dx} = \ldots$(1 *term correct*)

$\bullet^2$ $3x^2 - 6x - 9$

$\bullet^3$ $\frac{dy}{dx} = 0$

$\bullet^4$ $3(x+1)(x-3)$

	$\bullet^5$	$\bullet^6$
$\bullet^5$	$x = -1$	$x = 3$
$\bullet^6$	$y = 17$	$y = -15$

		$\bullet^7$			$\bullet^8$		
	x	…	-1	…	…	3	…
$\bullet^7$							
	$\frac{dy}{dx}$	$+$	0	$-$	$-$	0	$+$
$\bullet^8$		max			min		

Alternatives

This would be fairly common:

$\bullet^1$ √ $\frac{dy}{dx} = \ldots$(1 *term correct*)

$\bullet^2$ √ $3x^2 - 6x - 9$

$\bullet^3, \bullet^4$ √√ $(3x-9)(x+1) = 0$ *or* $(3x+3)(x-3) = 0$

Min. requirements of a nature table

x	…	-1	…
$\frac{dy}{dx}$	$+$	0	$-$
		max	

Preferred nature table

x	…	-1	…
$\frac{dy}{dx}$	$+$	0	$-$
	/	—	\
		max	

09 P2 Q2

3C, 3C

$\bullet^1$ $f(x^2-2)$

$\bullet^2$ $3(x^2-2)+1$

$\bullet^3$ $(3x+1)^2 - 2$

	$\bullet^4$	$\bullet^5$
$\bullet^4$	$3x^2 - 5$	$9x^2 + 6x - 1$
$\bullet^5$	$6x$	$18x + 6$ *or equiv.*

$\bullet^6$ $x = -\frac{1}{2}$

s / I by $\bullet^2$

s / I by $\bullet^5$

Alternative for $\bullet^1$ *to* $\bullet^3$:

$\bullet^1$ $f\big(g(x)\big) = 3 \times g(x) + 1$

$\bullet^2$ $f\big(g(x)\big) = 3\big(x^2-2\big)+1$

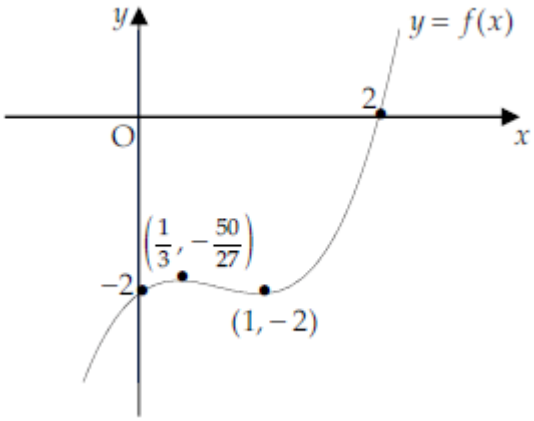
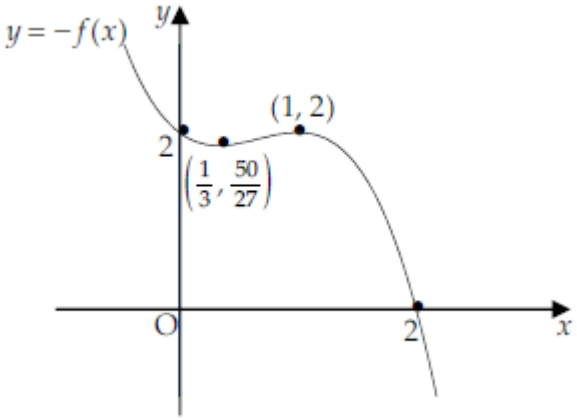
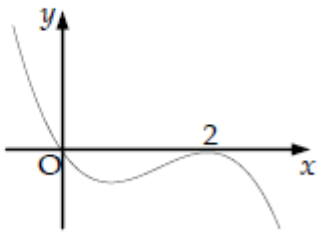
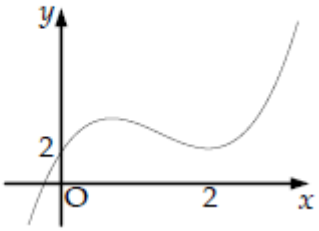
$g\big(f(x)\big) = \big(f(x)\big)^2 - 2$

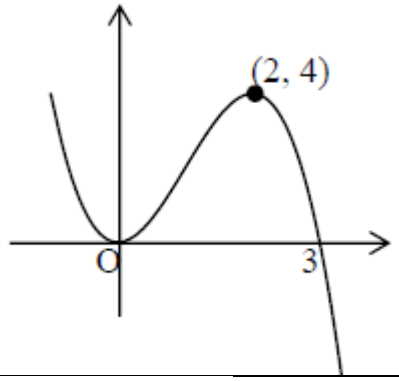
$\bullet^3$ $g\big(f(x)\big) = (3x+1)^2 - 2$

11 P1 Q22

interpret x intercept	$\bullet^1$	$(2, 0)$ (minimum response "(i) 2")
interpret y intercept	$\bullet^2$	$(0, -2)$ (minimum response "(ii) -2")
write in differentiable form	$\bullet^3$	$x^3 - 2x^2 + x - 2$
know to and start to differentiate	$\bullet^4$	$3x^2 \ldots$ or $\ldots - 4x \ldots$
complete derivative and equate to 0	$\bullet^5$	$3x^2 - 4x + 1$ **and** $f'(x) = 0$ **or** $3x^2 - 4x + 1 = 0$
factorise derivative	$\bullet^6$	$(3x-1)(x-1)$
process for x	$\bullet^7$	$\frac{1}{3}$ and 1 ¦ $x = \frac{1}{3}$ and $y = -\frac{50}{27}$
evaluate y-coordinates	$\bullet^8$	$-\frac{50}{27}$ and -2 ¦ $x = 1$ and $y = -2$
justify nature of stationary points	$\bullet^9$	x … $\frac{1}{3}$ … 1 …; $f'(x)$ $+$ 0 $-$ 0 $+$; max min
interpret and state conclusions	$\bullet^{10}$	

Accept a valid expression in lieu of $f'(x)$.

	•11 ic curve showing points from (a) and (b) without annotation •12 ic **cubic** curve showing **all** intercepts and stationary points annotated •13 ic curve from (i) reflected in $x-$axis   	
12 P2 Q3	start to differentiate complete derivative and set to 0 start to solve $f'(x)=0$ solve $f'(x)=0$ evaluate f at relevant stationary point consider end-points state max. and min. values	•1 differentiate x^3 or $-2x^2$ correctly •2 $3x^2-4x-4$ •3 e.g. $(3x+2)(x-2)$ } = 0 must appear at •2 or •3 to gain •2. •4 $-\frac{2}{3}$, 2 •5 $f(2)=-2$ •6 $f(0)=6$ **and** $f(3)=3$ •7 max. 6 **and** min. -2
12 P2 Q4	identify roots interpret point of inflection complete cubic curve reflection in x-axis translation $\begin{bmatrix}0\\2\end{bmatrix}$ annotation of 'transformed' graph Graph for (a)  	•1 0 **and** 2 only •2 turning point at (2, 0) •3 cubic, passing through O with negative gradient •4 reflection of graph in (a) in x-axis •5 graph moves parallel to y-axis by 2 units upwards •6 two 'transformed' points appropriately annotated Graph for (b) 
14 P1 Q21	know to differentiate and one term correct the other term correct and set derivative to 0	•1 $=6x....$ or $=....-3x^2$ •2 $6x-3x^2=0$ stated explicitly

	solve $\frac{dy}{dx}=0$	$\bullet^3$ $x=$ 0 (•3) 2 (•4)
	evaluate y coordinates	$\bullet^4$ $y=$ 0 4
	justify nature of stationary points	$\bullet^5$ use 2nd derivative or nature table
	interpretation	$\bullet^6$ min. at $(0,0)$ and max. at $(2,4)$
		0 2 $\frac{dy}{dx}$ − 0 + 0 −
	find intercepts	$\bullet^7$ $3x^2-x^3=0$ **and** $(3,0)$ or $x=3$ $(0,0)$ [may appear in part a]
	sketch	$\bullet^8$ sketch
		
14 P2 Q2	know to and differentiate	$\bullet^1$ $4x^3-6x^2$
	find gradient	$\bullet^2$ 8
	find y-coordinate	$\bullet^3$ 5
	state equation of tangent	$\bullet^4$ $y-5=8(x-2)$

ANSWERS **Pre 2000 – Basic Differentiation**

1	$\bullet^1$	know to expand
	$\bullet^2$	$2x^{\frac{3}{2}}+4x^{\frac{1}{2}}$
	$\bullet^3$	$3x^{\frac{1}{2}}$
	$\bullet^4$	$2x^{-\frac{1}{2}}$

2

$\bullet^1$ $4x^{-2}$ stated or implied by $\bullet^3$

$\bullet^2$ $+x^{\frac{3}{2}}$ stated or implied by $\bullet^4$

$\bullet^3$ $-8x^{-3}$

$\bullet^4$ $+\frac{3}{2}x^{\frac{1}{2}}$

3

$\bullet^1$ $\frac{dy}{dx}=4x+1$

$\bullet^2$ $LHS=x(1+4x+1)$ *or* $RHS=2\left(2x^2+x\right)$

$\bullet^3$ completes proof

4

$\bullet^1$ $\frac{dy}{dx}=2x-1$

$\bullet^2$ $RHS=1+\frac{2\left(x^2-x\right)}{x}$

$\bullet^3$ $1+2(x-1)$ and complete

5

$\bullet^1$ $6x^3-3x^2$

$\bullet^2$ $18x^2-6x$

$\bullet^3$ 24

6

$\bullet^1$ $\frac{x}{\sqrt{x}}-\frac{1}{\sqrt{x}}$ *or* $x\times x^{-\frac{1}{2}}-1\times x^{-\frac{1}{2}}$

$\bullet^2$ $x^{\frac{1}{2}}-x^{-\frac{1}{2}}$

$\bullet^3$ $\frac{1}{2}x^{-\frac{1}{2}}$

$\bullet^4$ $\frac{1}{2}x^{-\frac{3}{2}}$

$\bullet^5$ $\frac{5}{16}$

7

$\bullet^1$ $f'(x)=3kx^2+5$

$\bullet^2$ $f'(1)=3k+5$

$\bullet^3$ $k=3$

8

3C, 3C

$\bullet^1$ $f(x^2-2)$ **s / I by** $\bullet^2$

$\bullet^2$ $3(x^2-2)+1$

$\bullet^3$ $(3x+1)^2-2$

	$\bullet^4$	$\bullet^5$	
$\bullet^4$	$3x^2-5$	$9x^2+6x-1$	**s / I by** $\bullet^5$
$\bullet^5$	$6x$	$18x+6$ *or equiv.*	

$\bullet^6$ $x=-\frac{1}{2}$

9

$\bullet^1$ gradient $=-\frac{1}{3}$

$\bullet^2$ $f'(x)=$ gradient

10

$\bullet^1$ $\frac{dh}{dt}=\ldots\ldots$

$\bullet^2$ $19.6-9.8t$

$\bullet^3$ 9.8

$\bullet^4$ $\frac{dh}{dt}=0$

$\bullet^5$ $t=2$

Alternative

$\bullet^4$ $h(t)$ is a parabola which is **symmetric** about its **maximum**

$\bullet^5$ (*e.g.*) $h(1)=15\cdot9$, $h(2)=20.8$, $h(3)=15\cdot9$ *so* $t=2$

11	$\bullet^1$	knows to differentiate
	$\bullet^2$	$20-10t$
	$\bullet^3$	20
	$\bullet^4$	speed = 0
	$\bullet^5$	ball stationary at top of flight

ANSWERS **Pre 2000 – Equation of Tangent**

1	$\bullet^1$	$y' = 15x^2 - 12x$
	$\bullet^2$	$y'(1) = 3$
	$\bullet^3$	$y(1) = -1$
	$\bullet^4$	$y-(-1) = 3(x-1)$
2	$\bullet^1$	*strat:* $\frac{dy}{dx} = \ldots\ldots$
	$\bullet^2$	$f'(1) = 6$
	$\bullet^3$	$f(1) = 5$
	$\bullet^4$	$y-5 = 6(x-1)$
3	$\bullet^1$	*strat:* $\frac{dy}{dx} = \ldots\ldots$
	$\bullet^2$	$\frac{dy}{dx} = 12x^2$
	$\bullet^3$	$m = 12$
	$\bullet^4$	$y-(-6) = 12(x-(-1))$
4	$\bullet^1$	$\frac{dy}{dx} = \ldots\ldots$
	$\bullet^2$	$10x$
	$\bullet^3$	-10
	$\bullet^4$	$y-7 = -10(x-(-1))$
5	**(a)** $\bullet^1$	$\frac{dy}{dx} = \ldots$
	$\bullet^2$	$3x^2 - 8x + 2$
	$\bullet^3$	gradient $= -2$ (calculated from $\frac{dy}{dx}$)
	$\bullet^4$	$y_A = -5$
	$\bullet^5$	$y+5 = -2(x-2)$
	(b) $\bullet^6$	$m_{\text{normal}} = \frac{1}{2}$
	$\bullet^7$	angle $= \tan^{-1}\frac{1}{2}$

11	(a)	•1 $\frac{1}{x} = x^{-1}$
		•2 $\frac{dy}{dx} = \ldots\ldots$
		•3 $\frac{dy}{dx} = -x^{-2}$
		•4 gradient $= -a^{-2}$
	(b)	•5 use $y - \frac{1}{a} = -\frac{1}{a^2}(x-a)$
		•6 $a^2y - a = -(x-a)$ and completes proof
	(c)	•7 $y_B = \frac{2a}{a^2}$
		•8 $x_A = 2a$
		•9 2
		•10 independent of a

ANSWERS **Pre 2000 Questions – Tangent Problems**

1	•1	$\frac{dy}{dx} = \ldots\ldots$
	•2	$6x^2 - 6x - 12$
	•3	$\ldots\ldots = 0$
	•4	$x = -1, 2$
2	•1	$\frac{dy}{dx} = \ldots\ldots$
	•2	$3x^2 + 2kx - 8$
	•3	$3x^2 + 2kx - 8 = 0$ when $x = -2$
	•4	$k = 1$
3	•1	equate gradients
	•2	$m = -5$
	•3	$\frac{dy}{dx} = \ldots$
	•4	$\frac{dy}{dx} = 8x + 3$
	•5	$x = -1$
4	•1	$\frac{dy}{dx} = 3x^2 - 4$
	•2	$\frac{dy}{dx}_{x=2} = 8$
	•3	$\tan\theta = 8$
	•4	$83°$
5	•1	know to differentiate
	•2	$4 - 2x$
	•3	$m = 4$
	•4	$76°$
	•5	$45°$
	•6	$31°$

6

(a) •1 strategy: $\frac{dy}{dx} = \ldots\ldots = 3$

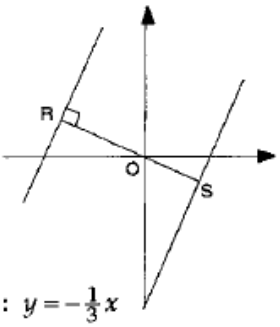
•2 $3x^2 - 9$

•3 $x = 2,\ -2$ **OR** •3 $x = 2,\ y = -6$

•4 $y = -6,\ 14$ •4 $x = -2,\ y = 14$

•5 $y + 6 = 3(x - 2)$

•6 $y - 14 = 3(x + 2)$



•7 $m_{RS} = -\frac{1}{3}$

•8 *equ of* RS : $y = -\frac{1}{3}x$

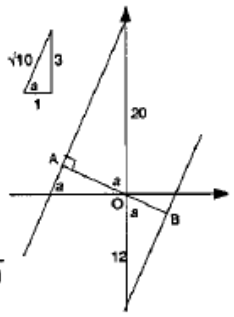
•9 $-\frac{1}{3}x = 3x - 12$ & $-\frac{1}{3}x = 3x + 20$

•10 $R(-6, 2)$ and $S\left(\frac{18}{5}, -\frac{6}{5}\right)$

•11 $d^2 = \left(-6 - \left(\frac{18}{5}\right)\right)^2 + \left(2 - \left(-\frac{6}{5}\right)\right)^2$

•12 $d^2 = \frac{48^2}{25} + \frac{16^2}{25}$ and completes proof

(b) •7 diagram with $y = -\frac{1}{3}x$



•8 for 20 and 12

•9 $AB = AO + OB$

•10 $AB = 20\cos a + 12\cos a$

•11 using $\tan a = \frac{3}{1}$

•12 $AB = 32 \times \frac{1}{\sqrt{10}} = 32 \times \frac{\sqrt{10}}{10} = \frac{32}{5}\sqrt{10}$

7

•1 $c = 3$

•2 $2ax + b$

•3 $m = \tan 45° = 1$

•4 $-2a + b = 1$

•5 $m = \tan 135° = -1$

•6 $4a + b = -1$

•7 method for solving pr. of equ

•8 $a = -\frac{1}{3},\ b = \frac{1}{3}$

ANSWERS **Pre 2000 – Stationary Points**

1

•1 for knowing to differentiate

•2 $f'(x) = 4x^3 - 6x^2 + 2$

•3 for putting $f'(x) = 0$

•4 for factorising **or** checking zeros

•5 $x = -\frac{1}{2},\ x = 1$

•6 $y = -\frac{27}{16},\ y = 0$

•7 completed nature table

x	$< -\frac{1}{2}$	$-\frac{1}{2}$	$> -\frac{1}{2}$	< 1	1	> 1
$f'(x)$	$-ve$	0	$+ve$	$+ve$	0	$+ve$
	\	—	/	/	—	/

•8 $(1,0)$ is pt. of inflexion, $\left(-\frac{1}{2}, -1\frac{11}{16}\right)$ is min t.p.

2

(a) •1 $\frac{dy}{dx} = \ldots\ldots$ *stated or implied* by •2

•2 $-4x^3 + 12x^2$

•3 $-4x^3 + 12x^2 = 0$ *or* $\frac{dy}{dx} = 0$ *explicitly stated*

•4 $-4x^2(x-3)$ (*accept* $x^2(-4x+12)$)

•5 $x = 0$ *and* 3

•6 $y = -2$ *and* 25

(b) •7

x	0^-	0	0^+	3	3^+
$\frac{dy}{dx}$					

•8 + 0 + 0 −

PI at $x = 0$, max *at* $x = 3$

3

(a) •1 $\frac{dy}{dx} =$

•2 $4x^3 - 12x^2$

•3 $= 0$ stated explicitly

•4 *e.g.* $4x^2(x-3)$

•5 $x = 0,\ 3$

•6 $y = 3, -24$

(b) •7

x	0^-	0	0^+	3	3^+
$\frac{dy}{dx}$	−	0	−	0	+

•8 pt of inflection at $x = 0$

minimum at $x = 3$

4

(a) •1 $\frac{dy}{dx} = 6x^2 - 12x$

•2 $\frac{dy}{dx} = 0$

•3 $x = 0,\ x = 2$

•4

x	0^-	0	0^+	2^-	2	2^+
$\frac{dy}{dx}$	+	−	+	+	−	+

•5 max. at (0,0) min at (2,−8)

(b) •6 $k < 0$

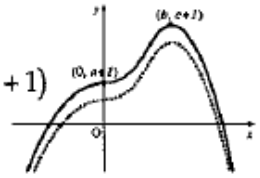
•7 $k > -8$

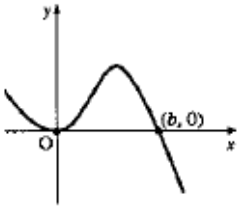
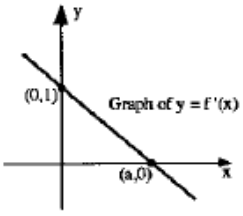
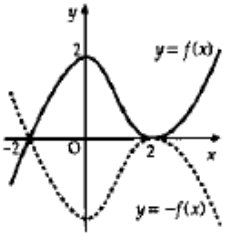
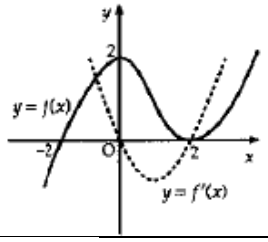
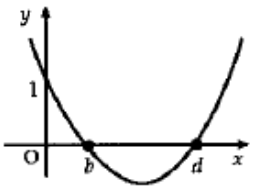
5	(*a*)	$\bullet^1$ $x=1,\ -2$
		$\bullet^2$ $(1,0)$ **and** $(-2,0)$
		$\bullet^3$ $(0,2)$
	(*b*)	$\bullet^4$ $f(x)=x^3-3x+2$
		$\bullet^5$ $f'(x)=3x^2-3$
		$\bullet^6$ $f'(x)=0$ **stated explicitly**
		$\bullet^7$ $x=1$ **and** -1
		$\bullet^8$ $\begin{array}{cccccccc} x & & -1^- & -1 & -1^+ & 1^- & 1 & 1^+ \\ f'(x) & + & 0 & - & - & 0 & + \end{array}$
		$\bullet^9$ max at $(-1,4)$
		$\bullet^{10}$ min at $(1,0)$
	(*c*)	$\bullet^{11}$ correct shape of sketch
		$\bullet^{12}$ correct annotation of sketch(max, min, 2 axes intersections)

ANSWERS **Pre 2000 – Increasing/Decreasing Functions**

1	$\bullet^1$	know to consider $f'(x)>0$ stated or implied by the evidence for $\bullet^4$.
	$\bullet^2$	$\frac{dy}{dx}=6x^2-6x-36$
	$\bullet^3$	$6(x-3)(x+2)>0$ or by formula or completing the square
	$\bullet^4$	$x<-2,\ x>3$
2	$\bullet^1$	$b=-10$
	$\bullet^2$	know to differentiate **and** know to show $\frac{dy}{dx}_{x=-2}>0$
	$\bullet^3$	$9x^2-2x-7$
	$\bullet^4$	show that $\frac{dy}{dx}_{x=-2}>0$
3	$\bullet^1$	$f'(x)=x^2-4x-5$
	$\bullet^2$	*use* $f'(x)>0$
	$\bullet^3$	zeros at $x=5$ **and** $x=-1$
	$\bullet^4$	*strat.* e.g. for $-1<x<5$ test $x=0$
	$\bullet^5$	$x<-1,\ x>5$

ANSWERS **Pre 2000 – Graphs of y = f '(x)**

1	$\bullet^1$	translation $\begin{pmatrix}0\\1\end{pmatrix}$
	$\bullet^2$	annotate $(0,a+1)$ & $(b,c+1)$ 

	$\bullet^3$ roots at $(0,0)$ & $(b,0)$ $\bullet^4$ $y' > 0$ for $x < b$, $y' < 0$ for $x > b$ $\bullet^5$ they coincide 
2	$\bullet^1$ $(-2,0)$ and $(3,0)$ $\bullet^2$ know how to find sign of f' over 3 intervals $\bullet^3$ min tp between $x = -2$ and $x = 3$ and no other
3	$\bullet^1$ $f'(a) = 0$ $\bullet^2$ m_{tgt} at $(0,0) = 1$ $\bullet^3$ $f'(0) = 1$ $\bullet^4$ for the sketch 
4	$\bullet^1$ for correct shape $\bullet^2$ for annotation $\bullet^3$ $f'(0) = 0$ $\bullet^4$ $f'(2) = 0$ $\bullet^5$ for correct shape  
5	$\bullet^1$ know that there are **exactly two** zeros $\bullet^2$ 0 **and** 2 $\bullet^3$ any parabola with max t.p. 
6	$\bullet^1$ **any one of** $f'(b) = 0, f'(d) = 0, f'(0) = 1$ $\bullet^2$ remaining two answers $\bullet^3$ shape of graph $\bullet^4$ annotation 
7	$\bullet^1$ clear evidence of reflection in $y = 0$ $\bullet^2$ clear evidence of translation $\begin{pmatrix} 0 \\ 2 \end{pmatrix}$ subsequent to a reflection $\bullet^3$ indication of passing through $(a,1)$ and $(b,2)$ $\bullet^4$ roots at $x = a$ and $x = b$ $\bullet^5$ parabolic shape with min. turning point between the roots and no other turning points $\bullet^6$ $\left(0, \frac{1}{2}\right)$